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A Framework for an Efficient Implementation of Logistics Collaborations

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Abstract. In order to beat the competition, access new markets and respect operational, social and environmental constraints, enterprises establish collaborations with many other business entities. Furthermore, with costs and information sharing, organizations have the opportunity to optimize their logistics activities. However, each enterprise has its own objectives and typically makes its own planning decisions to meet these objectives. Therefore, it becomes crucial to determine how business entities will work together as well as the value of the collaboration. Specifically, it is necessary to identify how logistics activities will be planned and executed, who will take the leadership of the collaboration and how benefits will be shared. In this article, we explain how efficiently build and manage inter-firms relationships. Moreover, we propose five coordination mechanisms that contribute to ensure information sharing, the coordination of logistics activities and the share of benefits. Case studies are used to demonstrate the utility of the framework.

Keywords. Enterprises collaborations, logistics and transportation, coordination mechanisms, collaborative planning, incentives, contracts, cost allocation, operational research.

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Introduction

In the current economic context, logistics collaboration is emerging as a new opportunity for improving key activities such as warehousing, transportation, and distribution. This is driven by heightened competitive pressure on a global scale, increased environmental concerns and new business models implementation. Moreover, collaboration in logistics has been identified as one means of reducing the cost of executing logistics activities, increasing the service level, gaining market shares, enhancing capacities and reducing negative impacts of the bullwhip effect (see for example Lee *et al.*, 1997 or Moyaux *et al.*, 2007). In addition, it has a positive environmental impact by making the operations more efficient.

On the other hand, logistics collaborations raise the need for specific methods to support the decision-making process and ensure the stability of the relationship. Partners will typically be ready to collaborate only if they can obtain greater benefits than the ones obtained individually. Therefore, it becomes crucial to determine how to build and manage collaborations efficiently, as well as how to share benefits equitably to ensure the long term stability of the collaboration. In particular, it is necessary to determine which entity or entities should lead the relationship, what are the specific objectives to aim and which information should be shared to support the collaboration. It is also essential to identify the value of the collaboration as well as how benefits will be shared.

In this paper, we explore how to build and manage profitable logistics collaborations (Figure 1). Specifically, we first explain the main stages for building an inter-firm relationship, namely the objectives to reach, the organisation of the collaboration to implement and the partners to select. Afterwards, we describe how to manage collaborations in order to ensure profitable long-term relationships. Therefore, different types of leadership are examined. Five generic coordination mechanisms are also proposed to support information sharing, the planning and execution of logistics activities, and the benefit sharing. These mechanisms aim to help managers in designing their collaboration schemes. Moreover, the nature of the information to share and the tools to implement so as to support the partnership are analyzed. Finally, we present three case studies that show how enterprises have implemented logistics collaborations in practice and we relate these case studies to the generic framework proposed. Some concluding remarks conclude the paper.

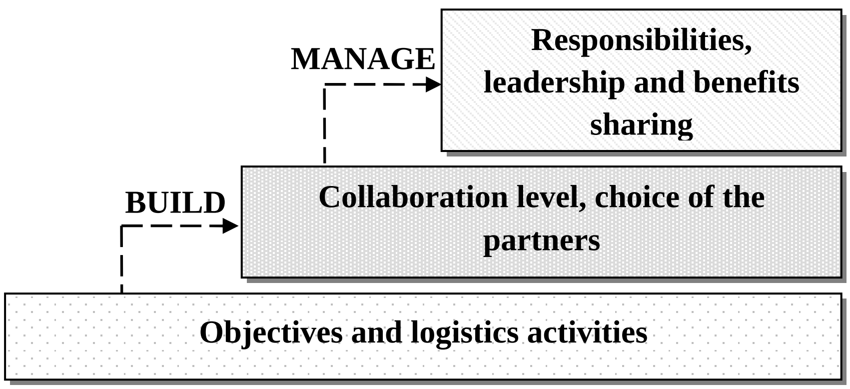


Figure 1. Building and managing logistics collaborations

Building logistics collaborations

Collaborations have been extensively studied in the litterature for different business contexts (see for example Lambert, 1996, Chen, 2003, Subrabami, 2004 Bagchi and Skjoett-Larsen, 2005 or van der Vaart and van Donk, 2008). Many definitions have also been proposed to describe the concept (see for example Table 1 in Fugate *et al.*, 2009). Here, we consider that collaboration occurs when two or more entities form a coalition and exchange or share resources (including information), with the goal of making decisions or realizing activities that will generate benefits that they cannot (or only partially) generate individually.

Futhermore, since collaborative relationships between organizations can vary in complexity, many frameworks have been proposed to describe their forms (see for example Frayret *et al.*, 2003). As shown in Figure 2, the nature of the information shared (i.e. on the Y axis) as well as the degree of interaction between partners (i.e. on the X axis) will differ depending on the type of relationships implemented.

In particular, they can be based on information sharing, aim a joint planning with or without a joint execution, or they can be established as a strategic alliance (e.g. co-evolution). In this paper, we will focus on collaboration that invovles either joint planning or collaborative planning and execution (framed in dotted lines in Figure 2).

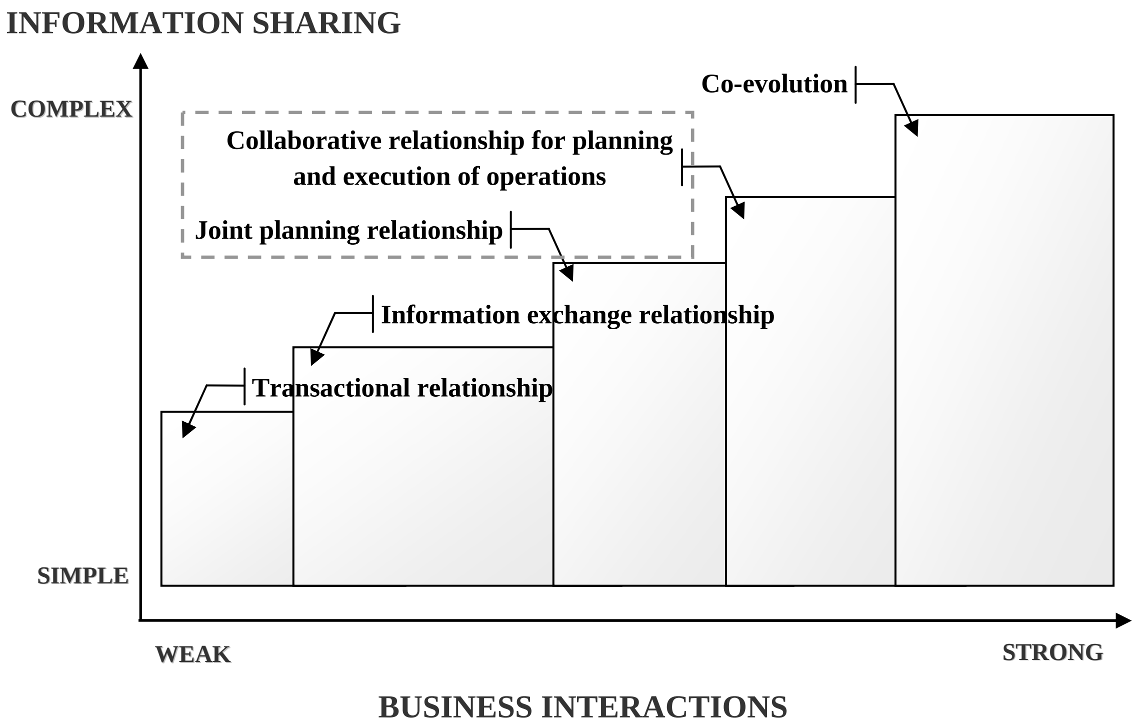


Figure 2. Forms of collaborative relationships (Frayret *et al.*, 2003)

Collaboration objectives

With the creation of inter-firms relationships, it becomes possible to increase the effectiveness of logistics operations. The logistics operations are costly activities that involve multiple actors for moving and storing products as they flow through the supply chain, thus they provide many opportunities for collaboration.

In transportation, the supply chain entities (i.e. carriers, shippers, customers, third party logistics (3PL), etc.) can optimize the loaded travelling time, the load capacity usage and the asset utilization. They share information in such a way that, in road transport for instance, the pick-up and delivery routing problems capture the benefits of a denser network of freight

(Ergun *et al.* 2007a, 2007b). Backhauling represents another opportunity to reduce the unloaded travelling distance. Carlsson and Rönnqvist (2007) have presented a survey on this concept applied to forestry transportation. The supply chain members can also face large transportation costs and aim to deploy new infrastructures that will provide them with a competitive advantage over others.

In addition, actors may collaborate to increase responsiveness and reduce costs such as the inventory holding cost. In such cases, they share demand and consumption information in a timely manner and use different approaches to synchronize their activities efficiently (Lehoux *et al.*, 2009b). Another common practice in collaborative logistics is to share spare parts between different entities.

What is important is that partners agree with the common objectives and are willing to act in such a way that these objectives will be reached. This commitment is crucial to establish long-term relationships (Ryu *et al.*, 2009).

Logistics activities and collaboration level

Collaboration can be strategic and, consequently, imply the sharing of key infrastructures or highly sensitive information. Examples of such collaborations could be the sharing of costly infrastructure such as pipelines (e.g. crude oil and gas), terminals (e.g. forestry), warehouses (e.g. retailing) or transportation modes (e.g. integrating train, ship, truck in general transportation organizations). The location and the investment for such infrastructures are considered strategic for the entities involved. Other strategic collaboration relates to defining industry standards. This is the case when entities of a same industry collaborate in order to define business standards which improve the interoperability of their systems. EDI is a good example of standards developed in order to share documents between organizations in a standardized electronic form and in an automated manner (Bhatt, 2001). PapiNet (see www.papinet.org) and StanForD (see Marshall, 2007) are other examples of standard created to ensure efficient information exchange in the forest products industry. Strategic collaboration can also imply a long term business contract and the share of demand and capacity information. At the strategic level, it is likely to see entities exchanging a complete model of their demand or capacity, in order to compute the most accurate value of their collaboration and establish a sharing strategy (Montreuil *et al.*, 1999, Frisk *et al.*, 2010). If they do not share a complete model, they usually obtain suboptimal benefits (Simatupang and Sridharan, 2002).

Collaborations can also be implemented to optimize the tactical and operational planning of some specific logistics activities. For example, Frisk *et al.* (2010) present a case study of collaboration in tactical transportation planning between eight forest companies, while Erikson and Rönnqvist (2003) analyze the collaboration in operational transportation planning between two companies and several carriers (these case studies are discussed in Section 3 with more details). Generally, collaboration at the operational level involves low commitment as well as less information sharing.

Forms of collaboration

Many authors differentiate collaboration according to two main dimensions: vertical and horizontal. The Figure 3, which is adapted from Barratt (2004), illustrates both dimensions from the perspective of a core company. In particular, the supply chain (b) includes the two production plants and the warehouse of the core company (i.e. the three black circles inside the delimited area numbered 3 in Figure 3).

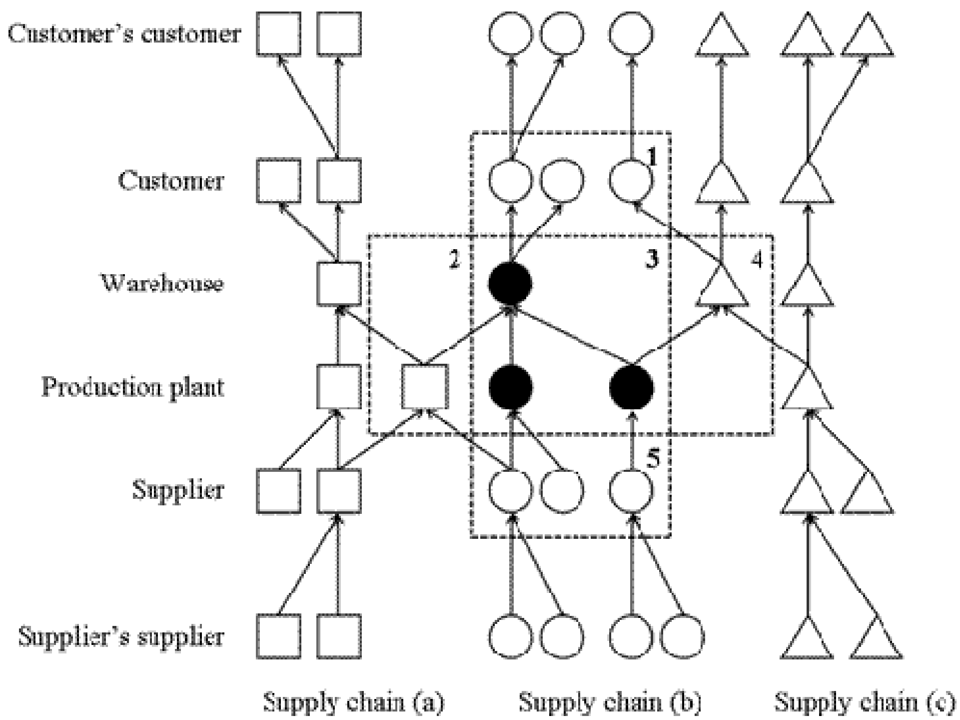


Figure 3. Dimensions of the collaboration

Vertical collaboration occurs with business units belonging to the same supply chain such as downstream with a supplier of the core company (i.e. delimited area numbered 5 in Figure 3) or upstream with a customer of the core company (i.e. delimited area numbered 1 in Figure 3, see also Figure 4). The share of information to reduce the bullwhip effect is a typical example of vertical collaboration between various entities located at different echelons in the same supply chain.

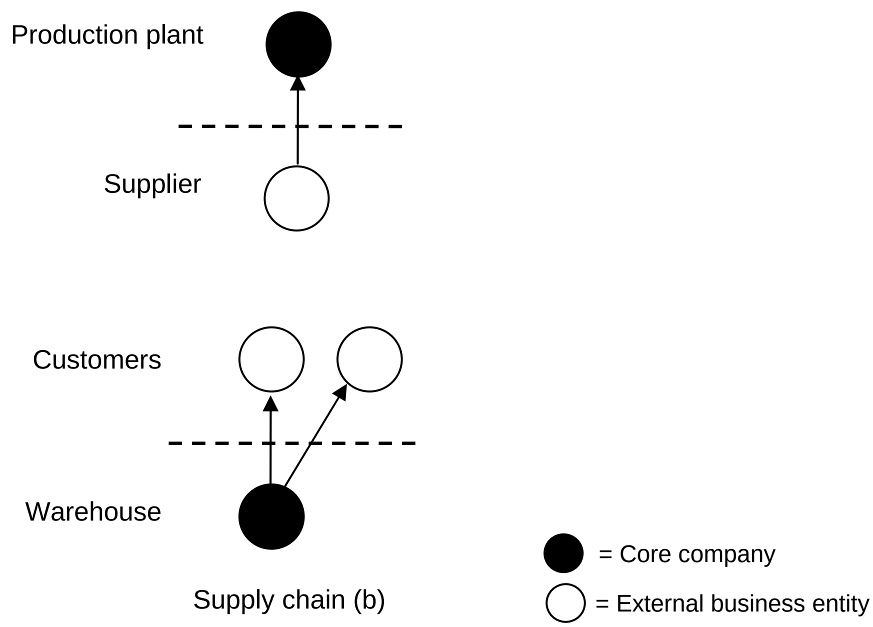


Figure 4. Vertical collaboration

Horizontal collaboration occurs with business units outside the supply chain, such as a competitor company with whom the core company can share warehousing capacity (i.e. delimited area numbered 4 in Figure 3) or a non-competitor company with whom the core company can share production capacity (i.e. delimited area numbered 2 in Figure 3, see also Figure 5). Group purchasing organizations are a typical example of horizontal collaborations among buyers belonging to different business units. Both vertical and horizontal collaboration can also occur within the core company between its own business units (i.e. delimited area numbered 3 in Figure 3).

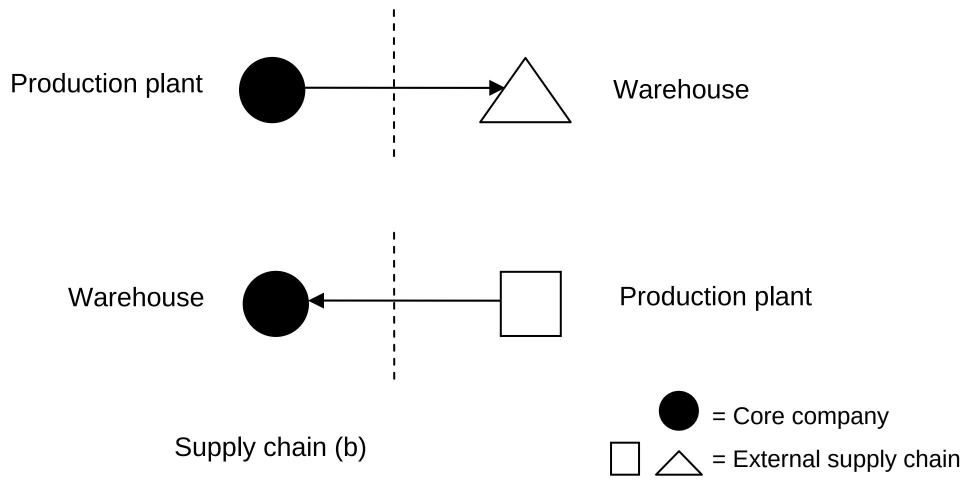


Figure 5. Horizontal collaboration

A third dimension of collaboration, which is the combining of both vertical and horizontal collaborations, has also been differentiated and designated as lateral, diagonal or synergistic collaboration (see for example case studies in Mason *et al.*, 2007).

Choice of the partners

Collaborations can bring together two or many entities. When two partners decide to work together, they can take the time to really know each other and build a trustful relationship. However, in a many-to-many context, this is a little more complicated. The design of proper collaboration mechanisms becomes difficult, mainly because the exchanges are not bilateral as in a supplier-customer relationship (Quélin, 2002). Moreover, some entities may enter with a lot to provide and little to gain, while others can benefit greatly with little to offer (see for example the case study involving eight entities in Frisk *et al.*, 2010). The right number of partners also depends on the industrial context. It is typically based on economic parameters as well as social factors (Kang *et al.*, 2007). However, larger collaborations are usually associated with an increase in coordination problems and in transactional costs. Futhermore, they may tend towards a smaller coalition value (Sombattheera and Ghose, 2006). Therefore, it is sometimes necessary to change some specific goals and even the culture of the relationship when new members are admitted into the coalition (Sreedharan and Vollmer, 2009).

In all cases, the selection of one or many partners needs to be made carefully. The right partner is the one who has a similar organization size, culture and philosophy. It also wants to pursue common goals and objectives, it is ready to share benefits as well as risk, and it uses similar technologies and planning techniques (Liu *et al.*, 2006). Moreover, it needs to contribute positively to the value of the collaboration. Ryu *et al.* (2009) have specified that trustful partnerships must be based on a cooperation strategy, complementary resources and an organizational compatibility. Based on 58 key performance indicators found through in-depth interviews and a literature study, Naesens *et al.* (2007) have also proposed an evaluation method for the strategic compatibility between two potential partners.

Nevertheless, collaboration can sometimes be imposed by one of the leading entities of the supply chain. For example, when Wal-Mart implemented RFID systems with all its major suppliers, the company imposed the technology on the different supply chain entities. Other imposed schemes can also be set by public policies. For example, natural resources can be managed by governmental authorities and the allocation rules may impose collaboration between many entities. This is the case in the forestry industry in Canada where the different entities are asked to find harvesting plans which meet the coalition members' needs (Beaudoin *et al.*, 2007).

Managing logistics collaborations

The management of collaboration in logistics involves determining who will be responsible for what, who will own the leadership, how benefits will be shared and which type of information will be needed.

Defining responsibilities

In a context where a supplier and a customer aim for more efficiency in their logistics, they can evaluate the possibility of sharing more information and jointly plan their operations. Therefore, several responsibilities can be shifted from one entity to another in order to improve the global effectiveness of the relationship.

For example, under a Vendor Managed Inventory (VMI) agreement, the producer is responsible for managing inventories of its customer. The customer provides the daily consumption to the producer so it can build a production-distribution plan that meets the fixed service level as well as optimizes the usage of its resources. This kind of strategies can contribute to increase the logistics performance as well as decrease the bullwhip effect. Danese (2006) reported the benefits gained by the pharmaceutical giant GlaxoSmithKline. De Toni and Zamolo (2005) also demonstrated how the application of VMI to the household electrical appliances sector resulted in more benefits than traditional replenishment systems. In addition, Dong *et al.* (2006) presented the benefits of implementing VMI for a context characterized by unknown demand. Another example of collaborative approach is Continuous Replenishment (CR), which is based on carrier capacity or production capacity.

The replenishment is structured around a pre-scheduled reservation of capacity. For example, the collaboration may set a one truck per day delivery to the customer. Then, the customer is responsible for setting the mix of products to be on the truck every day. This approach satisfies the needs of the customer over time and reduces the pressure on the producer. The same approach applies with capacity reservation (see for example Shen and Pang, 2004 or Durango-Cohen and Yano, 2006).

The Collaborative Planning, Forecasting and Replenishment business model (CPFR) is another illustration of collaborative models that aims to balance demand and production-distribution capacity upfront in order to define a win-win unique plan for both parties. To achieve this, information such as sales history, product availability, lead times, etc., must be shared so as to correctly synchronize activities and eliminate excess inventory. This method is also useful to rapidly identify any differences in the forecasts or inventory, in order to correct the problems before they negatively impact sales or profits. Thron *et al.* (2005) demonstrated that putting CPFR into practice can lead to substantial benefits, depending on the context studied. Cederlund *et al.* (2007) also reported reduction of 50% of transportation costs and 30% of inventory holding costs at Motorola.

Leader of the collaboration

Depending on the business context, the leadership of the relationship will usually differ. The size of the companies involved in the collaboration, as well as their contribution and organization’s philosophy, are some examples of parameters that will influence the leadership ownership. Therefore, it is possible that an entity, or several, lead the collaboration, deciding who should be admitted and how benefits should be divided (Kilger *et al.*, 2008). For example, Cruijssen *et al.* (2005) study a procedure allowing a 3PL (the leader in this case study) to form a coalition of shippers. Specifically, the 3PL uses the Shapley value (an economic model) to allocate the total transportation cost among the shippers involved. Levying a percentage of the collaboration savings, the 3PL aims to select inside the coalition the set of shippers that will generate the total higher savings. Other examples can be found in Cruijssen *et al.* (2007a) for the development of a hub distribution network among a set of shippers, and in Audy *et al.* (2009b) for the formation of a coalition of shippers by one or several of the shippers. Moreover, the ownership of the leadership can change over time or being exercised in different ways according to the phase of the collaboration (Stadtler, 2009).

Audy *et al.* (2009a) have identified six different forms of leadership currently used for collaboration in transportation (Table 1). Such models can also be generalized to other logistics collaborations. In these models, the leader is either one entity which aims to optimize its own objectives, or a group of many that aim to optimize a common objective. These forms of leadership are based on different purposes that often depend on the attitude of the leader(s). Furthermore, they will greatly influence the way of sharing costs and benefits.

Table 1: Forms of leadership for collaborative logistics

Model	Description of the leadership
1	A supplier/customer/producer leads the collaboration: it aims to minimize its transport costs by finding other customers/producers that can provide a good equilibrium (geographical, volume and time) between supply and demand.
2	A carrier/3PL leads the collaboration: it aims to maximize its profit by a better usage of its carrying capacity.
3	A coalition of suppliers/customers/producers shares the leadership of the collaboration: they aim to minimize their transportation costs.
4	A coalition of carriers/3PLs shares the leadership of the collaboration: they aim to maximize their profit by a better usage of their joint carrying capacity.
5	A coalition of carrier(s)/3PL(s) and supplier(s)/customer(s)/producers(s) shares the leadership of the collaboration: they aim to minimize their transportation costs by using the carrying capacity of the carriers.
6	A 4PL leads the collaboration: it aims to minimize/maximize the cost/profit of its partner.

Collaboration benefits

As observed by many authors (see for example Barratt, 2004, D'Amours *et al.*, 2006, Bailey and Francis, 2007, Cruijssen *et al.* 2007b, Ryu *et al.*, 2009, Chambost, McNutt and Stuart, 2009 or Lehoux *et al.*, 2009a), several benefits can be achieved through collaboration. Some are quantitative (e.g. cost reduction) while other qualitative (e.g. learning new logistics skills).

Evaluating benefits

In logistics, the evaluation of quantitative collaboration benefits is mainly conducted using Operational Research (OR) models (see e.g. Cruijssen *et al.*, 2005, Forsberg *et al.*, 2005, Beaudoin *et al.*, 2007, Cruijssen *et al.*, 2007a, Ergun *et al.*, 2007a, b, Agarwal and Ergun, 2008a, b, Clifton *et al.*, 2008, Lehoux *et al.*, 2008, Özener and Ergun, 2008, Lehoux *et al.*, 2009 and Frisk *et al.*, 2010). For example, the quantitative financial benefit for a planning problem with a minimization objective generally refers to a cost reduction (i.e. savings), whereas a planning problem with a maximization objective refers to a profit. Since most logistics problems are based on a minimization objective, we will refer to a savings for the potential financial collaboration benefit, except when we mention it as a profit.

In addition, in many of the previously mentioned case studies, the savings are defined according to the difference between the sum of the cost of each stand-alone solution (i.e. logistics activities planning of each entity alone) and the cost of the common solution (i.e. logistics activities planning of all entities together). These case studies rely on the assumption that the savings from a coalition of entities can be defined independently of the coalitions formed by other entities (i.e. there is no externalities).

Developing the planning models

In the literature, there exist many models for the planning of logistics activities for one entity (i.e. stand-alone solution). Modifications to such models are usually required in a context of logistics collaboration between several autonomous and self-interested entities (i.e. common solution). For example, in a case study of raw material exchange between two companies, Forsberg *et al.* (2005) report some additional constraints to their supply allocation model according to a different exchange scenario (e.g. a limit on the total volume that could be exchanged between companies). By adding constraints to the common problem, such modifications frequently reduce the potential savings of the collaboration. In a case study of raw material exchange on a monthly basis between three companies, Lehoux *et al.* (2009b) report that each company must remain the main supplier for its own mills (e.g. specified minimum percentage of 50%) and raw material exchanges must be pair-wise equal (i.e. a company must supply each collaborator with the equivalent volume received from this collaborator). These two modifications (or constraints in the problem) decrease the potential savings (ranged between 5-20%) by 1-2% each month.

Modifications to the individual planning problem of some companies can also be required. As previously mentioned, the solution value of the individual problem of one specific company represents its expected stand-alone cost. Consequently, to obtain a realistic value, the individual problem should be representative of the stand-alone logistics context of each company. For example, if a low volume shipping company A uses only less-than-truckload (LTL) carriers, while a high volume shipping company B uses only full-truckload (FT) carriers, the individual problem of each company must be adapted to fit such different cost functions. Otherwise, if the individual problem of both companies allows the use of LTL carriers only, the stand-alone cost of company B will be overestimated since with high shipping volumes, the use of FT carriers is cheaper than the use of LTL carriers.

Sharing the benefits

Collaboration benefits are generally classified into two main categories: qualitative and quantitative. While qualitative benefits typically cannot be shared among the entities, quantitative benefits can sometimes be shared (e.g. cost reduction), and sometimes not (e.g. delivery time reduction) (Figure 6). Moreover, the level of benefits achieved by each entity may differ.

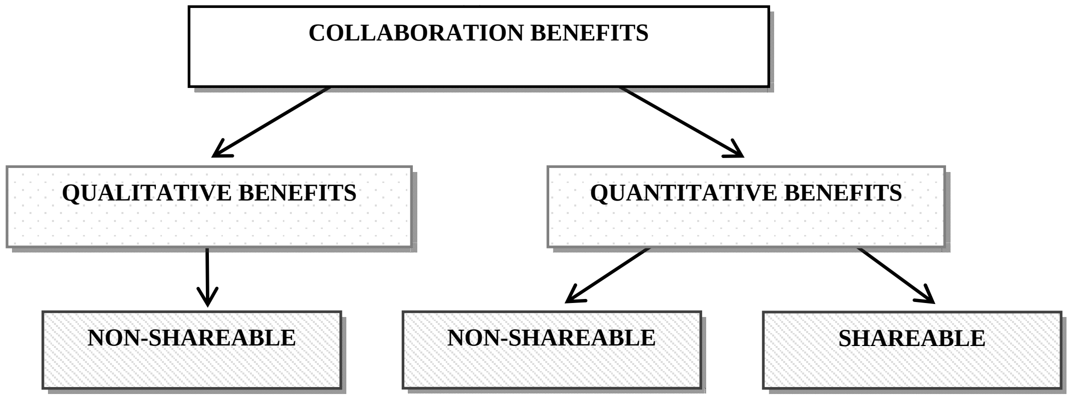


Figure 6. Type of collaboration benefits

Therefore, it is necessary to use methods which ensure that the benefits gained by each entity make the collaboration acceptable for everyone. The distinction between "shareable" and "non-shareable" benefits indicates how to change a situation for which the quantitative benefit gained by each entity makes the collaboration unacceptable for at least one entity.

Specifically, when a quantitative benefit is "shareable", a sharing method has to be used in order to redistribute the benefit among the entities in such a way that the collaboration becomes acceptable for everyone. However, if it is impossible for the entities to agree on a sharing method, no collaboration can be established (i.e. infeasible coalition). The addition/retreat of new/current entity(ies) to/from the infeasible coalition is consequently required to evaluate a new potential coalition.

When a quantitative benefit is "non-shareable", the planning problem needs to be modified since the solution of the planning problem will fix the distribution of the "non-sharable" benefits among the entities. This modification can be the addition of a constraint such as a maximum delivery date on each shipment, to ensure acceptable delivery time reductions for each entity. More complex modifications can also be required. For example, in their case study involving collaboration in transportation between four companies, Audy *et al.* (2008a) report that the planning problem using only full-truckload (FT) carriers did not respect the maximum delivery date for some shipments. Consequently, the planning problem was modified to allow the use of less-than-truckload (LTL) carriers in order to deliver these shipments on-time.

Coordination mechanisms

Usually, the logistics activities of the collaborating entities are first planned, and then benefits are computed and shared. However, new approaches have been recently proposed in the literature where both the planning of logistics activities and the sharing of benefits are computed simultaneously. The Figure 7 presents five generic coordination mechanisms (CM) that show these different approaches (each of them is described in the next subsections). Each mechanism involves at least two collaborating entities having logistics activities (e.g. transportation) and their own resources (e.g. carriers), both illustrated by a labeled circle. Even though collaborating entities may share resources (e.g. warehouse), this possibility is not illustrated to keep Figure 7 simple. Moreover, we restrict our discussion to financial benefits to simplify the description of each mechanism, despite the fact that these mechanisms support other benefits. A coordination process (illustrated by a diamond) realizes the planning of logistics activities and the sharing of the quantitative and shareable benefits. This coordination process can be performed by a third party or by the collaborating entities. In addition, information, decision and financial flows in each mechanism are illustrated.

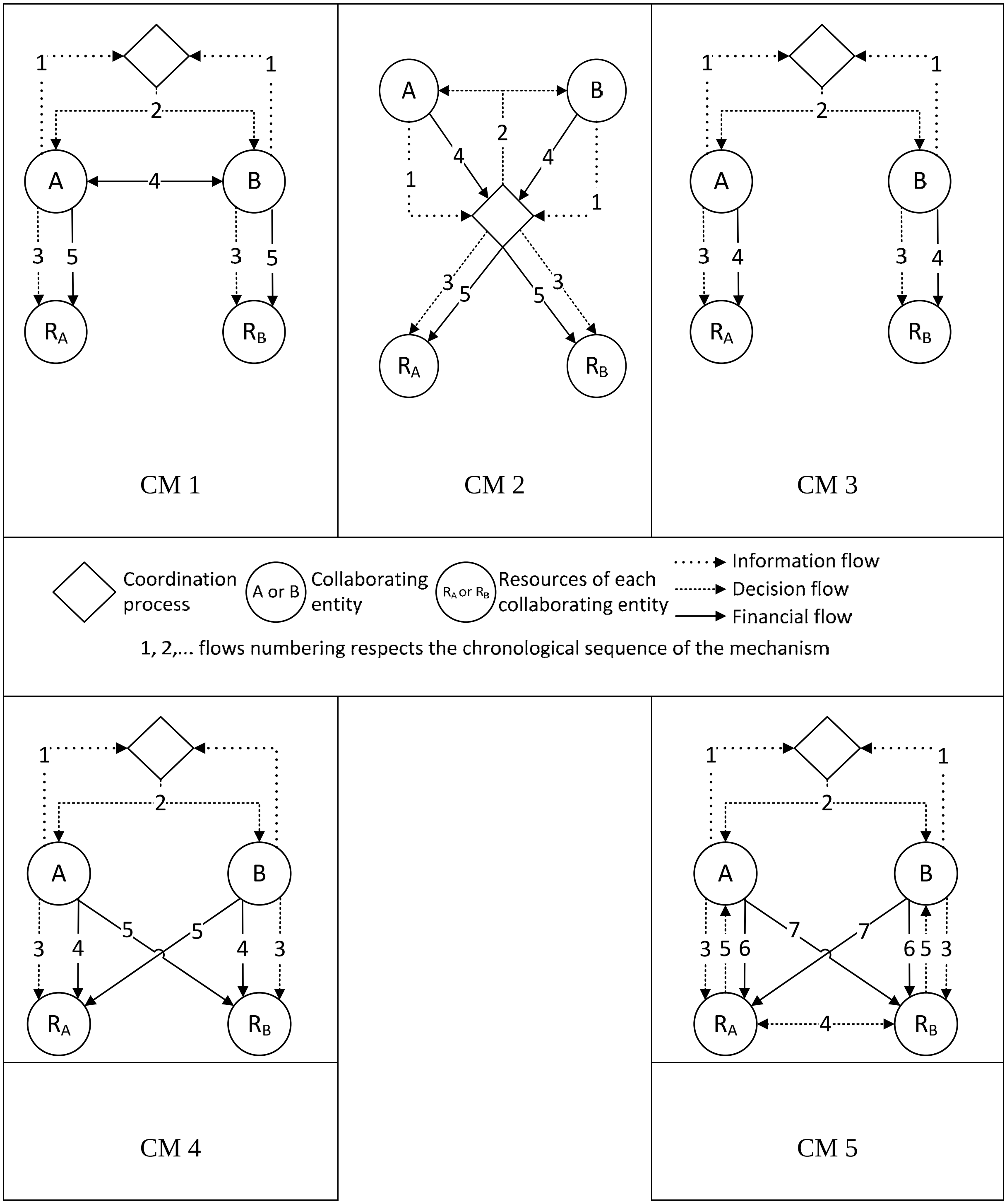


Figure 7. Generic coordination mechanisms for the logistics activities

These mechanisms are an adaptation of those proposed by Frayret *et al.* (2004) for collaborative logistics. More precisely, Frayret *et al.* (2004) present a classification scheme of the various coordination mechanisms for manufacturing activities in a distributed manufacturing system. A first class of coordination mechanisms, designated as ‘coordination by plan’ (from March and Simon, 1958), involves the establishment of predefined plans to coordinate a priori interdependent activities under the responsibility of autonomous and self-interested entities. This class is subdivided into three subclasses of mechanism: (i) ‘direct supervision with plan’, (ii) ‘mediation with plan’ and (iii) ‘joint plan establishment’. The first two subclasses use a third party to perform the coordination. In particular, in subclass (i), the third party performs a centralized planning of all entities’ activities and each entity must follow the centralized plan. In subclass (ii), each entity performs a first planning of their own activities and then, the third party performs an integration of these individual plans into one coherent-centralized plan that each entity must follow. Such integration involves modifications to the individual plans that are possible through the mediation between the third party and each entity. Therefore, the third party acts as a support (i.e. non-coercive) for the coordination rather than as a supervisor (i.e. coercive) like in subclass (i). In the third subclass (iii), with mutual adjustments between them, the entities perform joint planning of their activities to agree on a centralized plan that each company will follow.

Consequently, by adding benefit sharing within the mechanisms proposed by Frayret *et al.* (2004), we can address to problems of coordinating interdependent (i.e. vertical collaboration) or similar (i.e. horizontal collaboration) logistics activities and building profitable inter-firm relationships.

Coordination mechanism 1 (CM 1)

In this mechanism, the coordination process solves an optimization problem in order to achieve maximum savings and then, the benefit sharing is addressed with a financial flow between the business units. Such a financial flow is based on a predefined incentive rule such as pricing agreements or quantity discounts. A detailed review of these incentives can be found in Cachon (2003). Lehoux *et al.* (2009a) present a case study using coordination mechanism 1. The case study involves bilateral collaboration between a paper producer and a wholesaler. To establish the collaborative approach providing the greatest savings for the partnership as well as for both companies, the paper producer must share part of its transportation savings (i.e. incentive rule) with the wholesaler. Other examples can be found in Corbett *et al.* (2005), Sirias and Mehdra (2005), Hu *et al.* (2007), Xu and Weng (2007), Burer *et al.* (2008) and Yan *et al.* (2010).

Coordination mechanism 2 (CM 2)

In this mechanism, the coordination process solves an optimization problem in order to achieve maximum savings and then, the benefit sharing is addressed with a sharing principle based on an economic model (i.e. cost allocation method) such as the Shapley value, the nucleolus and the separable and non-separable costs. These economic models, which are usually based on cooperative game theory, lead to the allocation of the total cost of the common-solution among the companies. Nevertheless, there is no single and all-purpose economic model to achieve a fair and stable cost allocation. Cooperative game theory provides a set of desirable properties (e.g. efficiency) and equilibrium concepts (e.g. core) to define, respectively, fairness and stability. Therefore, when choosing an existing cost allocation method or developing a new one, it is necessary to seek one that satisfies specific properties which are considered essential in the context of the collaboration.

A survey of these economic models and equilibrium concepts can be found in Tijs and Driessen (1986) and in Young (1985), while a survey of their application in the field of Supply Chain Management can be found in Leng and Parlar (2005) and Nagarajan and Sošic (2008). Case studies using coordination mechanism 2 include Cruijssen *et al.* (2005), Cruijssen *et al.* (2007a), Audy *et al.* (2009b) and Frisk *et al.* (2010) for transportation activities, and Guo and Ding (2006) and Leng and Parlar (2009) for demand information sharing.

Coordination mechanism 3 (CM 3)

In this mechanism, the coordination process solves an optimization problem in order to achieve maximum savings, with respect to an additional constraint related to the benefit sharing. The optimization problem decides that certain activities belonging to an entity are accomplished by its own resource and others are accomplished by the resource of the second entity. Such decisions lead to the generation of two plans, one for each company. Since there is no financial flow between the entities or between the entity and the resource belonging to the other entity, the cost of the plan of each business unit must be, at least, less than the cost of their stand-alone plan.

In their case study involving three companies performing raw material pair-wise exchange, Lehoux *et al.* (2009b) report the use of this mechanism. These companies previously agreed with the sharing principle behind the Equal Profit Method (from Frisk *et al.*, 2010), an economic model that aims to find a stable allocation such that the maximum difference in relative savings between all pairs of two collaborating companies is minimized. Thus, to come up with a plan for each company that results in a benefit sharing for which each company could agree on, a new constraint has been added in the optimization problem. The new constraint states that each pair of companies must have the same relative savings.

Coordination mechanism 4 (CM 4)

In this mechanism, the coordination process simultaneously addresses the resolution of the optimization problem and the benefit sharing. For each activity, the optimization problem determines the cost to be paid for its completion by a specific resource. The computation of the cost takes into account the cost incurred by the resource to realize the activity as well as the revenue associated with the activity. Therefore, in this mechanism, the coordination process solves the optimization problem in order to achieve maximum profit instead of savings like in the four other mechanisms. For all the activities, each company pays this cost to its resource or to the one of the other company, according to which resource has been chosen in the planning. Thus, the benefit sharing is addressed with a financial flow between each company and the resource of the other company.

In Agarwal and Ergun (2008a), coordination mechanism 4 is used by sea container carriers sharing the loading capacity of their ships to deliver their respective customers' shipments. Other collaborative logistics case studies or examples using coordination mechanism 4 include Agarwal and Ergun (2008b) and Agarwal *et al.* (2009).

Coordination mechanism 5 (CM 5)

In this mechanism, the coordination process partially solves the optimization problem in order to achieve maximum savings. However, the coordination process does not provide an individual plan as in the other mechanisms. The plan rather includes for each entity's activity a list of potential collaboration opportunities involving other activities. This means that an opportunity may appear among the entity's activities, as well as among the entity's activities and the ones of another (or several) entity. At the assignment of the activities, each entity provides to its resource the list of potential collaboration opportunities. Given these opportunities, it is then up to the resources to decide together to collaborate or not, and if they collaborate, to decide together which resource will carry out the activities (i.e. flow 4). Since the resources are paid only for each activity they accomplish (i.e. flows 6 and 7), the decisions they make in flow 4 fixe the benefit sharing.

Mechanism 5 is based on a generalization of the mechanism used in the case studied by Eriksson and Rönnqvist (2003), which is illustrated in Figure 8. In this study, the potential collaboration opportunities are based on backhauling tours existing among the transportation activities of two forest companies. Moreover, this collaboration is realized through the carrier (i.e. the resource) of the second company.

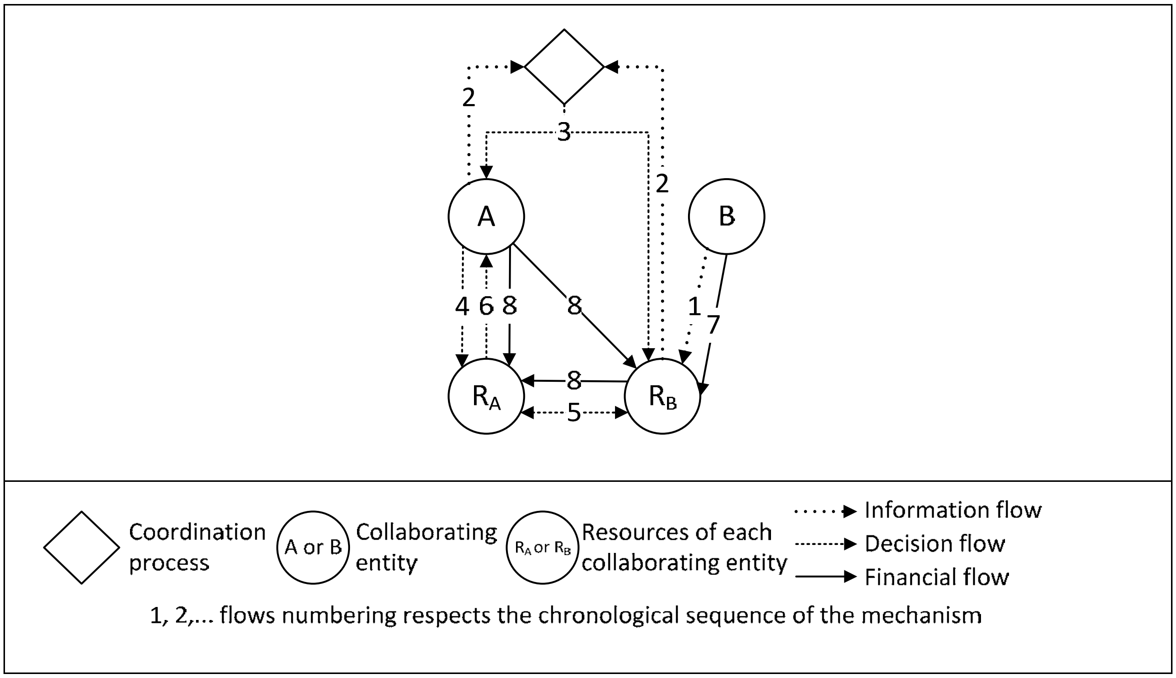


Figure 8. Coordination mechanism in the case studied by Eriksson and Rönnqvist (2003)

Information and advanced tools

If supply chain members want to build and manage efficient collaborations, they have to share information both upstream and downstream. Orders, sales forecasts, point of sales data and customer surveys, are examples of information that need to be sent top-down within the chain, while delivery plans, offers, promotion, capacity and inventory availability, have to be sent from the suppliers to the customers. In this way, the visibility is increase and each actor can make better planning decisions.

However, Fawcett *et al.* (2007) have observed four barriers that limit the positive impact of information sharing. The first barrier is the cost and the complexity of implementing advanced technologies. The investment can be very expensive and systems are sometimes not as high-performance as expected. The second barrier is incompatibility of systems which can really complicate the exchange of data. The third barrier refers to the “connectivity” problem across the organisation and across the value chain, reducing the positive impact of information sharing. Finally, there is a culture associated with the exchange of information and managers are not necessarily ready to share their knowledge with their partners. This is what the authors call “the willingness” dimension of information sharing. To this we add a fifth barrier: the information security and confidentially. Several approaches have been proposed in the literature in order to address such a barrier. For example, Clifton *et al.* (2008) examine the use of cryptographic techniques to perform collaborative logistics among potential competitors’ carriers without broker and with a strictly minimum share in information.

This challenge has motivated great efforts to standardize the information flow. Therefore, different standards such as RosettaNet (www.rosettanet.org) have been developed to support timeless and effective interoperability within the supply chain. The aim is to eliminate the need for negotiating and agreeing on data definitions and formats with each trading entity, each time a possible transaction occurs. A common messaging interface enables the entities to exchange rapidly with many different entities by means of electronic data exchange technology and to reduce errors in data treatment and exchange. Large corporations have started to use such standards to streamline their supply chain with their main customers (see for example www.papinet.org). Although multiple standards exist, many software enterprises develop their own model. In such cases, they typically use XML files to support the integration of the different technologies.

In logistics, application deals with different flows. The next table summarizes briefly the main information being exchanged when dealing with logistics (Audy *et al.*, 2009a).

Table 2: Information exchange in logistics planning

Activity	Description
Plan	Includes a set of information defining when, where and how the different activities will be conducted within a business unit or a set of business units. We can differentiate the following plans: source, make, deliver, sales, promotions and return.
Order	Specifies a specific need from a specific business unit at a specific time. The orders can be production orders, transportation orders, sales orders or return orders.
Delivery	Specifies a delivery of a specific product or service at a specific business unit at a specific time. The deliveries can provide products/services to a business unit within the supply chain as well as to the end user or end customer. A delivery can be a return.
Demand plan	A series of planned orders.
Supply plan	A series of planned deliveries.
Capacity plan	Defines the availability of the resources and their productivity.
Forecast	Anticipation of an order, a delivery or any plan.
Execution parameters	A series of parameters defining how the execution of the different tasks should be conducted.
Flow constraint	A series of constraints defining when and how the information flows can be exchanged.
Execution updates	Information on how the execution really went.

Information can also be shared to inform on the status or characteristics of the main element of the value chain, as given in the next table.

Table 3: Description of the main elements in the value chain

Element	Description
Product/service	Defines the characteristics of the product/service.
Process	Defines the process in terms of input, resource consumption and outputs.
Processor	Defines the characteristics of the processor.
Inventory	Defines the number of products kept in stock.
Factories	Defines a location.

To support the information flow required for collaboration, systems such as platforms are regularly used. Internet based technologies also provide many ways to connect the different entities and support their collaboration.

More specifically, agent-based technologies are rising as a new body of approaches building on distributed computing techniques. They intend to tackle the need for reactive, reliable, and (re)configurable operation management systems. An agent-based system may be defined as a system made of interdependent software agents designed to (i) individually handle a part of a problem, such as planning an order or dispatching a task to a carrier, and (ii) collectively carry out specific higher functions such as planning a shared warehouse. Software agents generally exhibit characteristics that allow them to individually behave and interact with each other in order to fulfill the purpose of the entire system. In such systems, information flows are supported by conversation protocols and messages. A conversation protocol links messages to form a conversation. As for messages, they have their own purposes and move from one sender to one or many receivers. The platform to support the flows of messages can vary greatly going from a blackboard where messages are posted to a real collaborative logistics eHub. Application of an agent-based platform for logistics collaboration is described in Audy *et al.* (2008b). It illustrates the Virtual Transportation Manager which is a web-based application permitting entities to post their transportation needs on a platform which thereafter optimizes the multiple pick-up and delivery transportation planning problem. The optimized routes, once accepted by the entities, are proposed to carriers.

Examples of logistics collaborations in the industry

In order to demonstrate the utility of the previous concepts and for validating the coordination mechanisms proposed, this section discusses three case studies illustrating how enterprises have implemented logistics collaborations in practice. The first case considers coordinated transportation planning in Sweden involving eight forest companies. The second case was conducted with four North American furniture manufactures aiming for co-distribution to the USA, while the third case is dealing with a vertical collaboration between a pulp and paper producer and a wholesaler. These cases have been selected because they are good examples of logistics collaborations. Specifically, they illustrated what kind of logistics activities can be optimized, how joint planning and execution can be conducted and how costs and profits can be shared. Moreover, the number of partners involved differs as well as the OR method used to solve the problem. The next table provides a summary of the properties of the three cases.

Table 4. Summary of the case studies

Case	**Total players**	**Leadership**	**Coordination mechanism**	**Industry**	**OR method**	**Stable equilibrium**	**Put into practice?**
1	8	3PL	3	Wood supply	LP	Yes - but not when implemented	Yes - by 3 players
2	4	Producer	2	Furniture	Heuristic	Yes - with cost allocation	Waiting
3	2	Producer	1	Paper	MILP	No - need incentives	Yes - CR

LP: Linear Programming
MILP: Mixed Integer Linear Programs

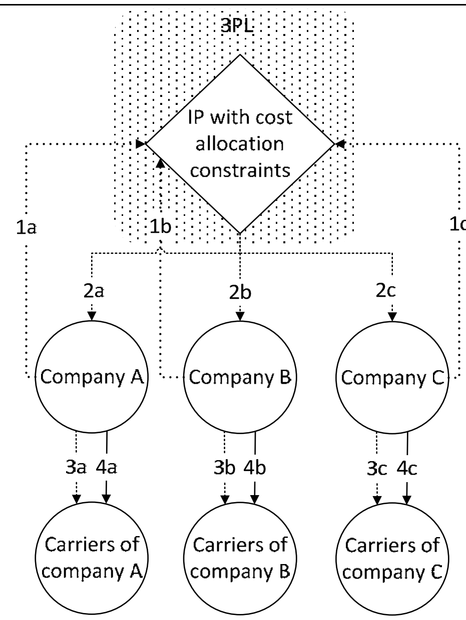
Wood supply collaboration in Sweden

This first case study is based on work done by the Forest Research Institute of Sweden with eight forest companies involved in transportation of logs from forest harvest areas to industries such as saw, pulp and paper mills (Frisk *et al.*, 2010). Transportation planning is an important part of the supply chain or wood flow chain in forestry. It often amounts to about a third of the raw material cost. There are often several forest companies operating in the same region and coordinated planning between two or more companies is rare. Wood bartering (or timber exchange) between forest companies to reduce transport cost is fairly common in Sweden. In wood bartering, two companies agree to deliver a specific volume to the others company's demand points. The company still plans its operations itself and there is no need to give away any sensitive information. Also, there is no need to provide information about the own savings to the other company.

In 2004, a group of eight forest companies in southern Sweden wanted to know the potential for coordinated transportation planning. Here, all companies viewed their supply and demand as common and a problem for one integrated artificial company could be done. This problem can be solved using the system FlowOpt (Forsberg *et al.*, 2005). The optimization model can be solved with a Linear Programming (LP) model. It turned out that the potential saving was as high as 14.2%. Some part comes from improved planning within each company and the part from collaboration was 8.7%. A very important question is how the savings or the cost should be distributed among the companies. Initially, the companies argued that the total cost should be based on their share of the overall volume. However, when we computed the relative savings, it was ranging from 0.2-20%. This difference was too high it was not possible to agree on. The reasons for this difference in relative savings are twofold. First, each company takes responsibility of their own supply and makes sure that it is delivered to the new destinations (coupling between supply and demand points). Secondly, the geographical distribution differs between companies and this affect the new distribution solution.

In order to come up with a sharing principle that the companies could agree on, several sharing principles based on economic models including Shapley value, the nucleolus, separable and non-separable costs, shadow prices and volume weights were tested and analyzed. As a part of the analysis, a new approach, called Equal Profit Method (EPM), was developed. The motivation was to get an allocation that provides an as equal relative profit as possible among the participants. In addition it satisfies core constraints from cooperative game theory and is a stable solution. This approach was acceptable among the forest companies. This was further extended in a two-stage process where the first identified volumes that make a contribution to the collaboration. Then the EPM was applied to these identified volumes.

As a result of the case study, three companies started in 2008 a collaboration where monthly coordinated planning was done (Figure 9). Before each month, each company provided the information about supply and demand to a third party logistics (i.e. represented by the dotted area in Figure 9), in this case the Forestry Research Institute of Sweden (i.e. the leader of the collaboration). Then an integrated plan (i.e. common plan) was done and the result was given back to the forest companies for their own detailed transportation planning. The sharing principle was based on having the same relative savings applied to each company own supply. In addition, there were some constraints making sure that each company is the main supplier for its own mills, and that pairwise exchange flows were the same. The latter is to avoid financial exchange between companies. Moreover, some core conditions were not included. With this revised model, it was not possible to guarantee a stable solution. The approach was tested during four months in 2008 and the potential savings were 5-15% each month.



Flow number	*Description*
1a,b,c	Each company sends to the coordination process the supply and demand volumes
2a,b,c	The coordination process sends to each company the volume and the destination of the supply volume.
3a,b,c	Each company sends to their carriers the volume to transport
4a,b,c	Each company pays their carriers.

Figure 9. Coordination mechanism 3 applied to the first case study

Outbound transportation collaboration

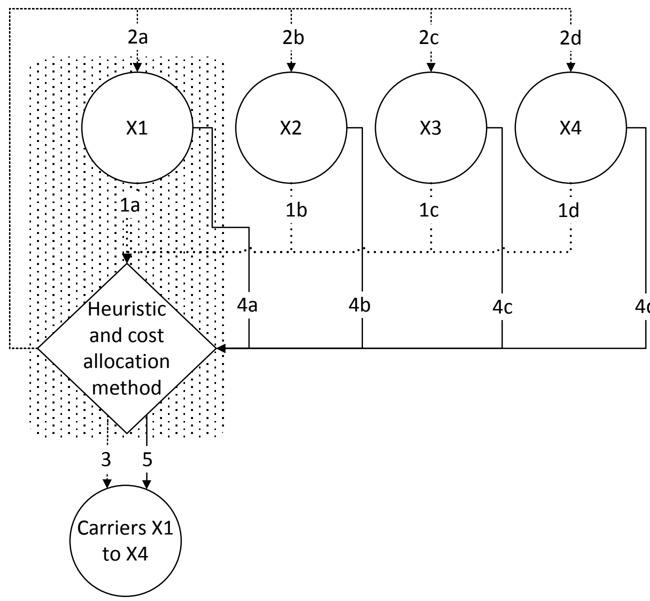
The second case study refers to the potential collaboration between four furniture manufacturers in Canada. The aim was to optimize collectively the outbound transportation of their products to the USA. In Audy and D’Amours (2008), four different logistics scenarios were explored to establish the collaboration. Cost and delivery time reductions as well as gain in market geographic coverage were identified in each scenario. However, even though a scenario can provide substantial benefits for the group, each company needs to evaluate the scenario according to its own benefits. This individual evaluation can lead to a situation where the scenario with the highest cost-savings for the group (optimal cost-savings scenario) does not provide the individual highest cost-savings to some companies or worse, provides one or more negative benefits. As a result, without any modification, this optimal cost-savings scenario would be rejected in favour of another scenario that may not capture all the potential cost-savings and may exclude some of the companies.

Audy *et al.* (2008a) integrated in the optimal cost-savings scenario the modifications which satisfy the conditions allowing its establishment by the whole group. However, by doing so, the result in cost reductions go from 21% to 12.9%. In other words, an additional cost of 8.1% was incurred in the collaborative plan to satisfy the heterogeneous requirements of some partners. Since some companies have more requirements than others and because the impact on cost increase between two requirements is almost never the same, this raises a new question: how the additional cost incurred to satisfy the special requirements should be shared between the companies? Using the solution concept of a cost allocation scheme called Alternative cost avoided method (see e.g. Tijs and Driessen, 1986), a new method was proposed and analyzed. This new method allows a share according to the impact of the requirements of each partner on the cost of the collaborative plan. Thus, the partner who increases the most the cost of the collaborative plan obtains the highest part of the additional cost incurred to satisfy the requirements of all partners. The previous costs allocated to each partner were then considered as a fix cost parameter in a sharing principle to determine the individual cost-savings of each company. The Equal Profit Method proposed by Frisk *et al.*

(2010) was used as the sharing principle with two modifications: (i) to tackle the previous fix cost parameter and also two other fix cost parameters typical to the furniture industry, and (ii) to ensure a minimum cost-savings percentage for each partner.

As a result of the case study, a pilot project was initiated by companies with the support of their industrial association. As agreed by the four companies, one of them, designated as the leader, defined a business agreement to manage the collaboration in the pilot project (Figure 10). However, the definition of the business agreement by the leading company was delayed for many reasons and then, two of the three companies cancelled the agreement. One company declared bankruptcy, while the second was suspected by the other companies of opportunistically using the monetary-related parameters, inside the proposition of agreement, to renegotiate downward its current transportation rates with its carriers. The benefit with the two remaining companies was judged insufficient and the project pilot was suspended.

Nevertheless, the leading company has recently joined a local organization regrouping several companies from different industrial sectors, and collaborative transportation is one of the strategies that members want to evaluate.



Flow number	*Description*
1a,b,c,d	The producers send the shipments to the coordination process.
2a,b,c,d	The coordination process sends to producers the delivery plan as well as the value of the cost to pay to the coordination process.
3	The coordination process sends to the carriers the route to execute.
4a,b,c,d	The producers pay the coordination process.
5	The coordination process pays the carriers.

Figure 10. Coordination mechanism 2 applied to the second case study

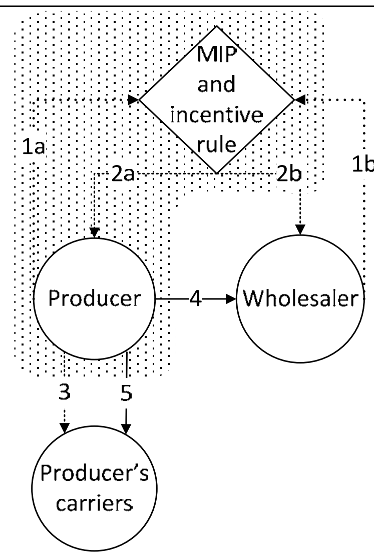
Collaboration approaches in the pulp and paper industry

The last case concerns a pulp and paper producer who decided to establish a partnership with one of its clients (vertical collaboration, see Lehoux *et al.*, 2009a). Since the production capacity was limited, the producer had to plan operations in order to satisfy the demand of the partner and the demand of other clients. The partner was a wholesaler, thus he bought products and sold them to consumers without transforming the merchandise. Even if each partner wanted to create a real partnership with mutual benefits, they made decisions based on their local costs rather than the global costs of the system. The producer planned operations in order to minimize production, distribution and inventory costs, while the wholesaler ordered products so as to minimize buying, ordering and inventory costs. For this context, the objective was to identify the collaborative approach to implement to ensure an efficient exchange of products and information as well as maximum benefits for the network and for each partner. Even though the wholesaler was a small company and, consequently, not one of the most important clients of the producer, a change in his order generally had a significant impact on production and distribution systems of the producer (small lot sizes that may not be produced or delivered economically). Therefore, the producer aimed to solve the problem by establishing collaboration with this wholesaler.

Four potential collaborative approaches were identified for the case study: a traditional system without any collaboration scheme, CR, VMI and CPFR. For each approach, decision models from the point of view of both the producer and the wholesaler were developed. Specifically, Mixed Integer Linear Programs (MILP) were used to take into consideration the costs, revenues and constraints involved in using each collaborative approach. Afterwards, models were tested and compared so as to find the approach the most profitable for the network. Results showed that CPFR generated the greatest total system profit because of an efficient optimization of both transportation and inventory costs (CPFR inventory cost was up to 44% lower than inventory costs of other models). VMI was second best since the transportation cost was optimized. CR and the traditional system obtained the lowest total system profit.

After comparing each model using the system profit, the investigation was based on the profit of each partner. Specifically, the different collaborative approaches were compared to verify if the same approach could generate the highest profit for both the producer and the wholesaler. This analysis revealed that CPFR generated the greatest profit for the producer, while CR was the most beneficial for the wholesaler. For this reason, a method for sharing benefits was defined so as to obtain a CPFR collaboration profitable for each partner. The experiments showed that if the producer shared a part of the transportation savings with the wholesaler, the profit of the wholesaler was higher than the profit obtained with CR, and the producer obtained a higher profit than the one generated by the other approaches (Figure 11).

At this moment, partners work together using a CR technique (Lehoux *et al.*, 2008). But in the future, they aim to implement a form of CPFR. Therefore, as the leader of the collaboration, the producer will certainly have to share benefits with the wholesaler in order to maintain a win-win relationship. Otherwise, it is possible that the wholesaler may prefer to work with someone else.



Flow number	*Description*
1a	The producer sends its supply.
1b	The wholesaler sends its demand plan.
2a	The coordination process sends to the producer the delivery plan and the value of the financial incentive to transfer to the wholesaler.
2b	The coordination process sends to the wholesaler the delivery plan and the value of the financial incentive to receive from the producer.
3	The producer sends to its carriers the volume to transport.
4	The producer pays the financial incentive to the wholesaler.
5	The producer pays its carriers.

Figure 11. Coordination mechanism 1 applied to the third case study

Concluding remarks

This paper explores how to build and manage efficient logistics collaborations. We have first described why enterprises choose to work together, what are the challenges faced by them, and what are the potential collaboration forms that they can implement. Next, we have explained how to manage collaborations in terms of responsibilities, leadership and benefits sharing. Some mechanisms have been presented in order to illustrate the different ways for planning and coordinating logistics activities and sharing information and benefits among partners. The nature of the information to exchange, as well as the tools needed to support the relationship, have also been explored. Finally, we have examined three case studies which illustrate how enterprises have implemented logistics collaborations in practice.

Many Operational Research tools can be used to study inter-firms collaborations. While in some cases, economic models are applied to address costs and benefits sharing, in other cases, optimization models and simulations are used to plan operations and identify the costs to share. Moreover, collaborations can be analyzed from different planning levels. It may concern the design of the coalition, the strategies or the technology to implement to support the collaboration, the day-to-day activities to jointly execute the operations, and so on. Collaborations can also be applied to different types of business contexts, from transportation activities to service companies.

Collaborations between supply chain entities are complex and many problems are still very difficult to deal with. These problems often call for interdisciplinary solutions and collaborative networks are emerging as a new discipline to study such collaborative issues

(Camarinha-Matos and Afsarmanesh, 2005). An example of issue is competition: In the process of building the partnership, some entities may be strong competitors. In such a case, trust may play an important role in the decision process. Legal issues are also very important. Many countries are concerned with potential collusive activities and therefore legislate to avoid them (e.g. antitrust law). The sharing of the benefit, although theory supports the process, may face the need to deal with benefits that are difficult to evaluate. For example, suppose there is a collaborative logistics project which permits an entity to access high value markets more easily, more rapidly and therefore develop them at low costs. What is the value of the increased geographical coverage or the faster deliveries? Finally, the collaboration is rarely fixed in time. The environment changes constantly as well as the parameters considered when designing the collaboration. How should this dynamic be considered upfront? How often should the terms of the collaboration be reviewed? These issues will certainly capture practitioners' attention in the next years.

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References

Agarwal, R., Ergun, Ö., 2008a. Network design and allocation mechanisms for carrier alliances in liner shipping. Under revision for *Operations Research*.

Agarwal, R., Ergun, Ö., 2008b. Mechanism design for a multicommodity flow game in service network alliances. *Operations Research Letters* 36(5), 520–524.

Agarwal, R., Ergun, O., Houghtalen, L., Ozener, O.O., 2009. Collaboration in cargo transportation. In: Chaovalitwongse, W., Furman, K.C., Pardalos, P.M. (Eds.). Optimization and Logistics Challenges in the Enterprise. Springer Optimization and Its Applications, Springer, New York, pp. 373-409.

Audy, J.-F., D'Amours, S., 2008. Impact of benefit sharing among companies in the implantation of a collaborative transportation system – An application in the furniture industry. IFIP International Federation for Information Processing, Pervasive Collaborative Networks, Springer, pp. 519-532.

Audy, J.-F., D'Amours, S., Rousseau, L.-M., 2008a. Cost allocation in the establishment of a collaborative transportation agreement - An application in the furniture industry. Forthcoming in *Journal of the Operational Research Society*.

Audy, J.-F., D'Amours, S., Rousseau, L.-M., Favreau, J., Marier, P., 2008b. Virtual transportation manager: a web-based system for transportation optimization in a network of business units. 3rd Forest Engineering Conference, Mont-Tremblant, Canada, October 1-4.

Audy, J.-F., D'amours, S., Lehoux, N., Rönnqvist, M., 2009a. A review on collaborative logistics. International Conference on Industrial Engineering and Systems Management (IESM'2009), Montreal, Canada, May 13-15.

Audy, J.-F., D'Amours, S., Rönnqvist, M., 2009b. Analysis of building coalitions and savings sharing - Application to round wood transportation. In revision in *International Journal Production Economics*.

Bagchi, P. K., Skjoett-Larsen, T., 2005. Supply chain integration: a European survey. *International Journal of Logistics Management* 16(2), 275-294.

Bailey, K., Francis, M., 2008. Managing information flows for improved value chain performance. *International Journal of Production Economics* 111, 2-12.

Barratt M., 2004. Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: An International Journal* 9(1), 30-42.

Beaudoin, D., LeBel, L., Frayret, J.-M., 2007. Tactical supply chain planning in the forest products industry through optimization and scenario-based analysis. *Canadian Journal of Forest Research* 37(1), 128-140.

Bhatt G. D., 2001. Business process improvement through electronic data interchange (EDI) systems: an empirical study. *Supply chain Management: An International Review* 6(2), 60-74.

Burer, S., Jones, P.C., Lowe, T.J., 2008. Coordinating the supply chain in the agricultural seed industry. *European Journal of Operational Research* 185, 354-377.

Cachon G. P., 2003. Supply Chain Coordination with Contracts. In de Kok, A.G., Graves, S.C. (Eds.), Handbooks in operations research and management science. Elsevier, Amsterdam, pp. 229-339.

Carlsson, D., Rönnqvist, M., 2007. Backhauling in forest transportation: models, methods, and practical usage. *Canadian Journal of Forest Research* 37(12), 2612-2623.

Camarinha-Matos, L.M., Afsarmanesh, H., 2005. Collaborative networks: A new scientific discipline. *Journal of Intelligent Manufacturing* 16 (4-5), 439-452.

Cederlund, J. P., Kohli, R., Sherer, S.A., Yao, Y., 2007. How Motorola put CPFR into action. *Supply Chain Management Review* October 2007, 28-35.

Chambost, V., McNutt, J. Stuart, P.R., 2009. Partnerships for successful enterprise transformation of forest industry companies implementing the forest biorefinery. *Pulp & Paper Canada* May/June 2009, 19-24.

Chen F., 2003. Information Sharing and Supply Chain Coordination. In de Kok, A.G., Graves, S.C. (Eds.), Handbooks in operations research and management science. Elsevier, Amsterdam, pp. 341-421.

Clifton, C., Iyer, A., Cho, R., Jiang, W., Kantarcioglu, M., Vaidya, J., 2008. An approach to securely identifying beneficial collaboration in decentralized logistics systems. *Manufacturing & Service Operations Management* 10 (1), 108-125.

Corbett, C.J., Decroix, G.A., Ha, A.Y., 2005. Optimal shared-savings contracts in supply chains: Linear contracts and double moral hazard. *European Journal of Operational Research* 163(3), 653-667.

Cruijssen, F., Borm, P., Fleuren, H., Hamers, H., 2005. Insinking: a methodology to exploit synergy in transport. CentER Discussion Paper 2005-121, Tilburg University, Netherlands.

Cruijssen, F., Borm, P., Dullaert, W., Hamers, H., 2007a. Joint hub network development. CentER Discussion Paper 2007-76, Tilburg University, Netherlands.

Cruijssen, F., Dullaert, W., Fleuren, H., 2007b. Horizontal cooperation in transport and logistics: a literature review. *Transportation Journal*, 46 (3), 22-39.

D'Amours, S., Frayret, J.-M., Rousseau, A., Harvey, S., Plamondon, P., Forget, P., 2006. Agent-based Supply Chain Planning in the Forest Products Industry. In IFIP International Federation on Information Processing (Volume 220), Springer, pp.17-26.

Danese P. 2006. The extended VMI for coordinating the whole supply network. *Journal of Manufacturing Technology Management* 17(7), 888-907.

De Toni, A. F., Zamolo, E., 2005. From a traditional replenishment system to vendor-managed inventory: A case study from the household electrical appliances sector. *International Journal of Production Economics* 96, 63-79.

Dong, A. H., Wong, W. K., Chan, S. F., Yeung, P. K. W., 2006. Improve production balance for apparel supply chain adopting VMI replenishment strategy. Proceedings of the International Conference on Management of Innovation and Technology, Piscataway, NJ, pp. 848-852

Durango-Cohen, E., Yano, C. A., 2006. Supplier commitment and production decisions under a forecast-commitment contract. *Management Science* 52(1), 54-67.

Ergun, O., Kuyzu, G., Savelsbergh, M., 2007a. Reducing truckload transportation costs through collaboration. *Transportation Science* 41(2), 206-221.

Ergun, O., Kuyzu, G., Savelsbergh, M., 2007b. Shipper collaboration. *Computers & Operations Research*, 34(6), 1551-1560.

Eriksson, J., Rönnqvist, M., 2003. Decision support system/tools: Transportation and route planning: Åkarweb – a web based planning system. 2nd Forest Engineering Conference.

Fawcett, S.E., Osterhaus, P., Magnan, G.M., Brau, J.C., McCarter, M., 2007. Information sharing and supply chain performance: the role of connectivity and willingness. *Supply Chain Management: An International Journal* 12(5), 358–368.

Frayret, J.-M., D'Amours, F., D'Amours, S., 2003. Collaboration et outils collaboratifs pour la PME [Collaboration and collaborative tools for manufacturing SMEs]. CEFRIO Technical Report.

Frayret, J.-M., D'Amours, S., Montreuil, B., 2004. Co-ordination and control in distributed and agent-based manufacturing systems. *Production Planning and Control* 15(1), 1-13.

Frisk, M., Jörnsten, K., Göthe-Lundgren, M., Rönnqvist, M., 2010. Cost allocation in collaborative forest transportation. *European Journal of Operational Research* 205, 448-458.

Forsberg, M., Frisk, M., Rönnqvist, M., 2005. FlowOpt – a decision support tool for strategic and tactical transportation planning in forestry. *International Journal of Forest Engineering* 16(2), 101-114.

Fugate, B. S., Davis-Sramek, Goldsby, B. T. J., 2009. Operational collaboration between shippers and carriers in the transportation industry. *International Journal of Logistics Management* 20 (3), 425-447.

Guo, B.-c. Ding, H.-p., 2006. Information Sharing Value and Its Allotment in Multi-level Supply Chain. Proceedings of 2006 International Conference on Management Science and Engineering, ICMSE'06 (13th), October 5 – 7, 571-576.

Hu, L.-y., Chunyu, Y.-q., Jiang, Z.-s., 2007. Research on the coordination mechanism model of the three-level supply chain. Proceedings of the 14th International Conference on Management Science & Engineering, Piscataway, NJ, pp.734-739.

Kang, K., Zhang, J., Xu, B., 2007. Optimizing the Selection of Partners in Collaborative Operation Networks. Proceedings of the 3rd International Conference on Intelligent Computing: Advanced Intelligent Computing Theories and Applications, pp. 836-850.

Kilger, C., Reuter, B., Stadtler, H., 2008. Collaborative Planning. In : Stadtler, H., Kilger, C., (Eds.). Supply Chain Management and Advanced Planning: Concepts, Models, Software, and Case Studies, Springer-Verlag, Berlin Heidelberg, pp. 263-284.

Lambert, D.M., Emmelhainz, M.A., Gardner, J.T., 1996. So you think you want a partner? *Marketing Management* 5(2), 24-40.

Lee, H.L., Padmanabhan, V., Whang, S., 1997. Information Distortion in Supply Chain: the Bullwhip Effect. *Management Science* 43(4), 546-558.

Lehoux, N., D'Amours, S., Langevin, A., 2008. A win-win collaboration approach for a two-echelon supply chain: a case study in the pulp and paper industry. To appear in *European Journal of Industrial Engineering*.

Lehoux N., D'Amours, S., Langevin, A., 2009a. Collaboration and decision models for a two-echelon supply chain: a case study in the pulp and paper industry. *Journal of Operations and Logistics* 2(4), VII.1-VII.17.

Lehoux, N., Audy, J.-F., D'Amours, S., Rönnqvist, M., 2009b. Issues and experiences in logistics collaboration. In: Camarinha-Matos, L., Paraskakis, I., Afsarmanesh, H., (Eds.). IFIP, Springer, pp. 69-77.

Leng, M., Parlar, M., 2005. Game theoretic applications in supply chain management: A review. *Information Systems and Operational Research* 43 (3), 187-220.

Leng, M., Parlar, M., 2009. Allocation of Cost Savings in a Three-Level Supply Chain with Demand Information Sharing: A Cooperative-Game Approach. *Operations Research* 57(1), 200-213.

Liu, D, Roberto Boër C., Sacco M., Fornasiero, R., 2006. A networked engineering portal to support distributed supply chain partnership. *International Journal of Computer Integrated Manufacturing* 19(2), 91-103.

March, J. G., Simon, H.A., 1958. Organizations. John Wiley & Sons, New York.

Marshall, H., 2007. Log merchandizing model used in mechanical harvesting. In: Weintraub, A., Romero, C., Bjorndal, T., Epstein, R., (Eds.). Handbook of Operations Research in

Natural Resources, International Series in Operations Research and Management Science, Kluwer Academic Publishers, New York, pp. 379-389.

Mason, R., Lalwani, C., Boughton, R., 2007. Combining vertical and horizontal collaboration. *Supply Chain Management: An International Journal* 12(3), 187-199.

Montreuil, B., Frayret, J.M., D’Amours, S., 1999. A Strategic Framework for Networked Manufacturing. *Computers in Industry* 42(2-3), 299-317.

Moyaux, T., Chaib-draa, B., D'Amours, S., 2007. The impact of information sharing on the efficiency of an ordering approach in reducing the bullwhip effect. *IEEE Transactions on Systems, Man, and Cybernetics* Part C 37(3).

Naesens, K., Gelders, L., Pintelon, L., 2007. A swift response tool for measuring the strategic fit for resource pooling: a case study. *Management Decision* 45 (3), 434-449.

Nagarajan, M., Sošic, G., 2008. Game-theoretic analysis of cooperation among supply chain agents: review and extensions. *European Journal of Operational Research* 187 (3), 719-745.

Özener, O.Ö., Ergun, Ö., 2008. Allocating costs in a collaborative transportation procurement network. *Transportation Science* 42 (2), 146-165.

Quélin B. (2002). Les frontières de la firme. Economica, Paris.

Ryu, I., So S., Koo, C., 2009. The role of partnership in supply chain performance. *Industrial Management & Data Systems* 109(4), 496-514.

Shen, H., Pang, Z., 2004. Supply chain coordination via capacity options with uncertain demand and supply. Proceedings of the International Conference on Systems, Man and Cybernetics, IEEE, New York.

Simatupang, T.M., Sridharan, R., 2002. The collaborative supply chain. *International Journal of Logistics Management* 13(1), 15-30.

Sirias, D., Mehra, S., 2005. Quantity discount versus lead time-dependent discount in a inter-organizational supply chain. *International Journal of Production Research* 43(16), 3481-3496.

Sombattheera, C., Ghose, A., 2006. A Distributed Branch-and-Bound Algorithm for Computing Optimal Coalition Structures. In Antoniou, G. *et al.* (Eds.), Lecture Notes in Computer Science, Springer-Verlag, Berlin.

Sreedharan, P., Vollmer, D.D., 2009. Partnerships for Sustainability: Past, Present, and Future. In: Vollmer, Enhancing the Effectiveness of Sustainability Partnerships: Summary of a Workshop, National Academies Press, Washington.

Stadtler H. (2009). A framework for collaborative planning and state-of-the-art. *OR Spectrum* 31, 5-30.

Subramani M. (2004). How do suppliers benefit from information technology use in supply chain relationships? *MIS Quaterly* 28(1), 45-73.

Thron, T., Nagy, G., Wassan, N., 2005. The impact of various delivery prioritization strategies in heterogeneous supply chain environments. Proceedings of the 3rd International Industrial Simulation Conference, Eurosis-ETI, Ghent, pp. 262-268.

Tijs, S.H., Driessen, T.S.H., 1986. Game theory and cost allocation problems. *Management Science* 32 (8), 1015-1058.

Van der Vaart, T., van Donk, D. P., 2008. A critical review of survey-based research in supply chain integration. *International Journal of Production Economics* 111, 42-55.

Xu, X.-s., Weng, M., 2007. Quantity flexibility contract design in supply chain under adverse selection. Proceedings of the 14th International Conference on Management Science & Engineering, Piscataway, NJ.

Yan, X., Zhang, M., Liu, K., 2010. A note on coordination in decentralized assembly systems with uncertain component yields. *European Journal of Operational Research* 205, 469-478.

Young H.P. (1985). Cost allocation: methods, principles, applications. North-Holland, Amsterdam.